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The mine of the future – Even more sustainable

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ABSTRACT

Sustainability is something that is ever important but not necessarily easy to progress. It can get rather complex quite quickly and with diverse and critical stakeholders, we have to be very systematic. This paper is a discussion on sustainability over the years with a focus on the changes seen in the mining industry.

Despite somewhat heroic efforts by the industry to take a coordinated approach to sustainability, it is clear that many see mining as broken.

The paper discusses some of the technical advances both near term and longer that will ensure that mining is seen as sustainable and that companies are seen as integrated development partners. The mine of the future will be very deep, will have a negligible footprint, much lower energy requirements and will only bring to the surface the primary products required by an increasingly circular economy.

1. Introduction: sustainability as a journey

Sustainability is ever important as a self-evident common good. Few would argue against a principle that aims to ensure stable or ever improving living standards, or more generically, that future generations should not have their choices limited. The topic is not new. We can turn to (Malthus, 1872) in his essay on the evils of population growth as sowing the seeds of the sustainability debate. His essay is still seen as a topic for debate in modern economics (Brander, 2007). It is hard to argue against the principle that unmitigated population growth would strain resources to the point of limiting the growth, let alone living standards. That said, the green revolution in agriculture has permitted a global population (most likely) unimaginable to Malthus.

Perhaps the most focusing debate in modern times was the publication of The Limits to Growth (Meadows et al., 1972). The book focuses repeatedly on sustainability and particularly the need to alter "growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future." The Club of Rome used the analysis to emphasise that we live in a finite system. Their long term predictions of running out of oil (1992), natural gas (1994) and finally coal (2083) have long since been shown to be in error. This has led to much criticism of the work as ignoring the nature of technology or the fact that resources are still in abundance, albeit with lower grades and higher energy requirements. Recent work however (Turner, 2014) suggests that the base case of the Limits to Growth aligns well with current data with first signs of a general collapse appearing around 2015. Turner suggests peak oil and energy resource constraints as key factors. One might argue however that the current selling price for oil (excluding exploration and development costs) is still a factor of 3 above the marginal cost of production. The base scenario in limits to growth is still well short of reality.

Close inspection however indicates that Meadows et al. (1972, page 130) were in fact well aware that "There are no substantial limits in sight either in raw materials or in energy that alterations in the price structure, product substitution, anticipated gains in technology and pollution control cannot be expected to solve". The real criticism of the work is that it underestimated the impact of technology in terms of improving pollution levels and bringing down costs. One notes that for commodities in general and for mineral commodities in particular, over the long term price in real terms keeps falling (Fig. 1).

This trend is hardly driven by discovery of ever higher grades but more by the relentless March of technology. One might even define a commodity as something whose price falls in real terms indefinitely. Should a finite limit ever occur, substitution would then apply.

It is easy to adopt a non-critical view that sustainability issues concerning finite resources will be solved by technology but equally, the relentless advances in technology are often underestimated. As pointed out in the narrative, (Williamson et al., 2015) it is technology that is central to human existence. A tangential but informative aspect is to note, that technology is a great leveler. As production increases, costs come down over orders of magnitude (Fig. 2).

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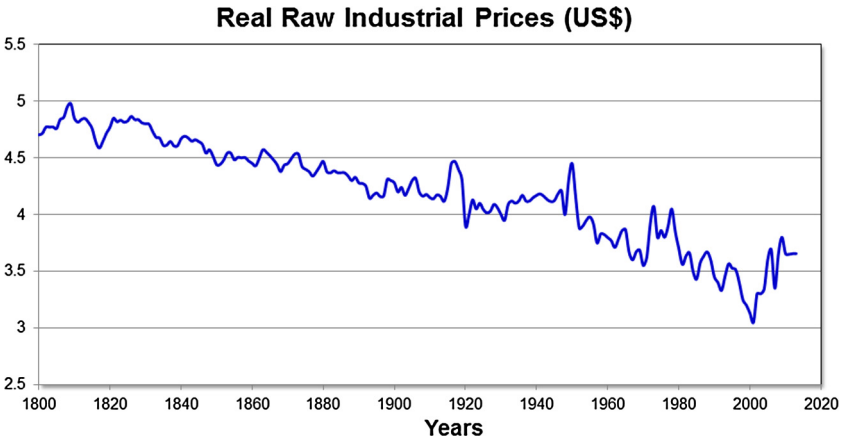

Fig. 1. Commodities have been a terrible investment in real terms, over the long run. BCA Research. Adjusted by U.S. GDP deflator; shown as a natural logarithm.

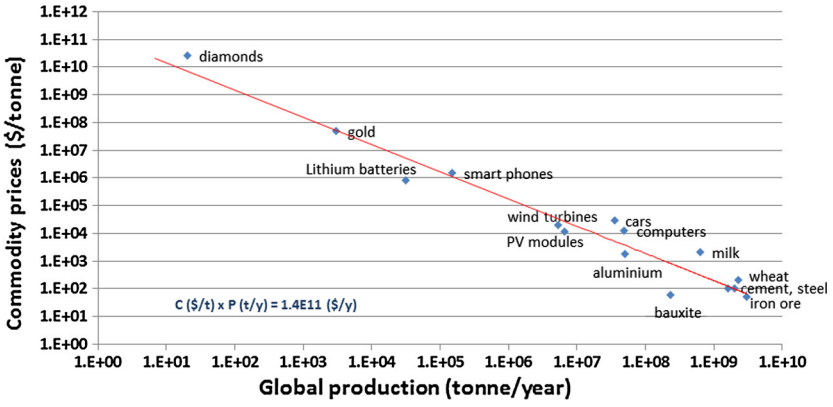

Fig. 2. Unit costs and global production are strongly related (Batterham, 2015).

2. The sustainability journey for mining

Probably the most significant event after the Club of Rome activity was the publication of the Brundtland (2009) report. We are all well familiar with its focus on sustainability and its simple definition of sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". The simplicity of the definition is beguiling but as to measurement and the ability to compare and choose between alternatives, no consensus has ever been reached (Batterham, 2006).

For the mining industry at a corporate level there have always been requirements on stewardship (award of licences and allocation of royalties and taxes), environmental performance requirements (often ever increasing) and the need to satisfy shareholder expectations or risk going out of business. While lofty ideals such as The Natural Step (Robert, 1989) seem to offer a quantitative approach they can be difficult to apply in the context of mining. More specifically, the Natural Step requires mining not to produce materials any faster than they are returned to the Earth's crust. Even just from an energy perspective, this is not simple (Gutowski et al., 2013). As well, an urbanizing and growing population requires at least for some years more materials. More realistically, mining companies tread a progressive line somewhere between "staying out of jail" in terms of regulation and the wider public licence to operate and the pursuit of a myriad of goals (waste minimization, product purity, utilization of bi-products, social investment, etc.) that in summation would bankrupt a company.

For many in the industry, the journey in more recent times has centred on the so called triple bottom line, attributed to Elkington (1997) but in the literature much earlier (Spreckley, 1981). It provides headings for companies to report, albeit still descriptive rather than allowing quantitative comparisons in an absolute sense. At least the headings are readily comprehensible, eg People, Planet, Profits or Social, Environment and Economic. To these banners and in response to public pressure, a fourth pillar is often added, viz Governance (Rio Tinto, 2014).

To some extent, the public licence to operate has always been a priority. The revolution that closed Bougainville Copper operations in 1989 (Anon, 2013) is but one reminder that withdrawal of the public licence to operate can take quite extreme forms. Equally dramatic in terms of halting progress can be Government moratoriums, e.g. that by the Victorian Government on fracking (ABC, 2012) while targeting non-conventional gas production in effect bans the mine of the future as outlined in this paper.

Understanding the stakeholders would seem to be the key to maintaining the public licence to operate. As Reggio and Lane (2012) show, this is far from simple (Fig. 3) and, even with attention to detail, there is no guarantee of success, merely a better chance of procuring and maintaining the licence to operate.

Some would argue that stakeholder engagement is nothing new and is a continuous part of an effective sustainability strategy. This is reasonable but tends to hide the fact that significant changes can take many years to negotiate, e.g. the 7 years required for Rio Tinto in the Pilbara to negotiate a new stakeholder agreement even after 20 years of effective collaboration with stakeholders (Rio Tinto,

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